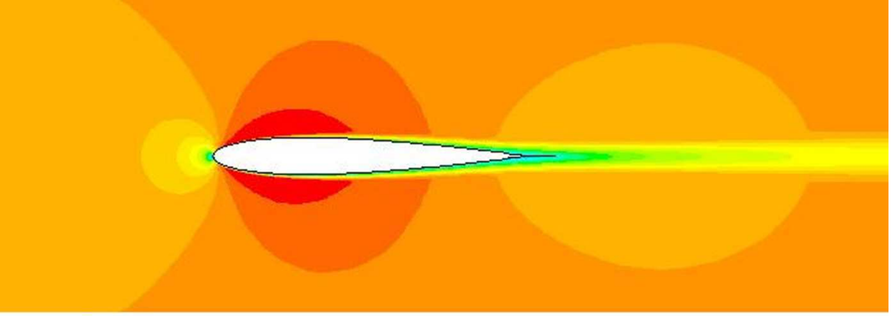

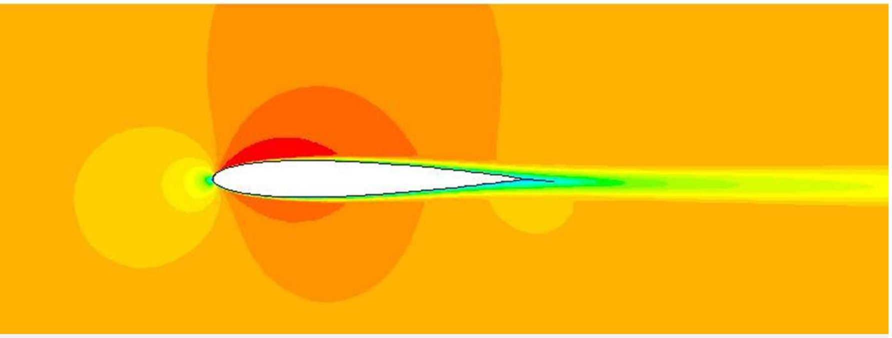

National Aeronautics and Space Administration

Aeronautics

Biologically Inspired Wing Flow Control

Airfoil/ Wing Flow Control Using Flexible Extended Trailing Edge

Flaps can significantly alter wing aerodynamics for high lift generation. Conventional flaps are mainly deployed for takeoff and landing but are not suitable for in cruise flight. It is widely speculated that birds and insects utilize their wing flexibility particularly at the trailing edges for effective control in different regimes. For example, the avian wing geometries of mergansers and owls possess a single layer of feathers extended from an airfoil section of their wings, which improves the global aerodynamic characteristics. Avian wing geometry inspired the concept of a static extended trailing edge (SETE), as shown in Figure 1, where the main airfoil is extended at the trailing edge by attaching a flexible polymer membrane with suitable length and rigidity. Based upon experimental results and CFD simulation it was determined that if SETE was implemented on a fixed wing aircraft, it had the potential to improve cruise flight aerodynamic efficiency up to 10% and reduce fuel consumption up to 5%.

BENEFITS

- Improves fuel efficiency
- Allows greater suppression control
- Can prevent stalling from flow separation
- Existing airframes can be easily modified to use technology
- Technology can be mounted on trailing edge or in other locations

APPLICATIONS

- Fixed wing aircraft
- Helicopter airfoils
- Wind turbines
- Unmanned Air Vehicles (UAVs)

technology solution

THE TECHNOLOGY

Applied to a typical aluminum airfoil on a fixed wing aircraft, the technology involves adding a flexible strip which can adjust itself to the air flow to obtain drag reduction. Alternatively, sensors and actuators can be used for feedback control to make adjustments to the strip to optimize drag reduction. Depending on specific applications, the strip could be of an aluminum plate, polymer membrane, composite sheet or smart material plate. The effects of SETE on the wing aerodynamics are mainly due to modifications of the airfoil camber and of the flow structure at the trailing edge. The resulting improvement in aerodynamic efficiency leads to greater fuel efficiency and vibration control. For small aircraft like unmanned aerial vehicles (UAVs), the device can prevent flow separation, which can lead to stalling. The cover photo shows the asymmetry of the flow field induced by SETE where wake is turned downward, indicating a deflected momentum stream tube and generation of additional lift. The wake structure is not appreciably altered indicating that the parasite drag is not significantly affected. Figure 2 is a CFD simulation at 6 degree deflection.

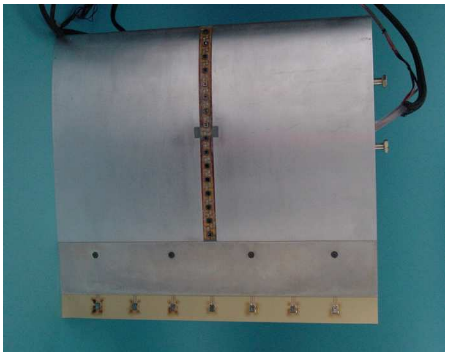

Fig. 1: Static Extended Trailing Edge (SETE).

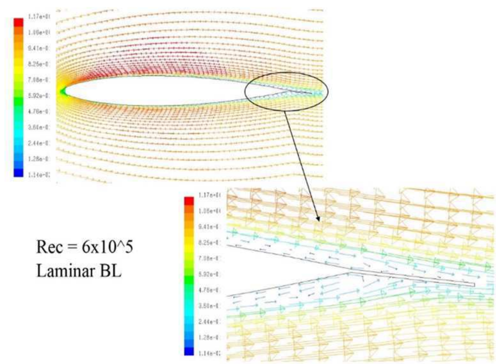

Fig. 2: Simulation at 6 degree deflection.

PUBLICATIONS

Patent No: 8,882,049

T. Liu, Montefort, W.W. Liou, S. R. Pantula, Q. A. Shams, "Static Extended Trailing Edge for Lift Enhancement: Experimental and Computational Studies", 3rd International Symposium on Integrating CFD and Experiments in Aerodynamics, 20-21 June 2007. Available at http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070 030823.pdf.

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